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THE GASTEROMYCETES OF AUSTRALASIA.

iv. SPECIES OF THE GENUS *GEASTER*.

By G. H. CUNNINGHAM, Government Mycologist, Wellington, N.Z.
(Plates ii-vii.)

[Read 31st March, 1926.]

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Members of the genus *Geaster* are popularly known as "earth-stars", on account of the stellate nature of the expanded exoperidium of certain species. All are saprophytic, growing upon vegetable debris on the forest floor, under hedges or in open pastures. Most species have a wide but sparse distribution, for the greater number have been found on all continental areas. Five species are confined to this biological region.

Structure of the Mature Plant.

The mature plant is seen to consist of two well-defined groups of tissues—the exoperidium and the endoperidium.

Exoperidium.

This structure is usually split to about the middle into a variable number of rays, 5-14 or more, but this number is not constant, even in the same species. The rays may be expanded, revolute or involute; those plants possessing rays which are involute when dry (or during dry weather) are said to be hygroscopic, those with rays which remain expanded (or revolute) are said to be non-hygroscopic. The base of the exoperidium may be saccate, when it usually partially encloses the endoperidium, or convex, when the endoperidium appears as if raised upon a small dome. The exoperidium consists of three well-defined tissues: (1) The mycelial or outer layer; (2) the fibrillose or middle layer; and (3) the fleshy or inner layer.

(1) *Mycelial layer*.—This, the exterior layer, is well seen in plants ere they have expanded. If the plants are epigaeal, the exterior is seen to be either felted-tomentose (*G. velutinus*) or comparatively smooth (*G. triplex*). In the former case the whole of the exterior is covered with a dense palisade, 1-2 mm. thick, of stout, persistent hyphae; in the latter the mycelial layer is almost wanting, and forms a thin, frequently evanescent layer of thin-walled hyphae arranged radially. This soon flakes away, exposing the fibrillose layer.

If plants are hypogaeal, the mycelial layer is composed of long hyphae arising from all parts of the plant and ramifying for some distance into the substratum. Consequently, when such plants become expanded, the mycelial layer either holds the exoperidium permanently to the substratum, or, as more frequently happens, the exoperidium is torn away from the substratum, the mycelial layer then holding firmly to the exterior of the exoperidium quantities of vegetable debris. This debris may persist, but as the plant becomes weathered usually flakes away in irregular patches.

In three species (*G. fenestriatus*, *G. minus* and *G. radicans*) the two inner layers frequently split away from the mycelial layer (which remains as a cup

attached to the substratum) save at the apices of the rays, and become arched upwards until they assume a strongly fornicate appearance. Such a condition is common with *G. fenestriatus*, less so with *G. minus*, and apparently rare with *G. radicans*. This fornicate condition is not of specific value, for collections are frequent in which both fornicate and non-fornicate forms are present.

(2) *Fibrillose layer*.—This tissue consists of intricately woven hyphae of two kinds, arranged with their long axes predominantly radial. The inner portion (next the fleshy layer) is strengthened by numerous thick-walled hyphae similar to those of the capillitium. The fibrillose layer is at the base attached to the endoperidium and, when present, the columella and pedicel. The whole tissue is tough and membranous, and in old plants is frequently the only remaining tissue of the exoperidium.

(3) *Fleshy layer*.—This inner tissue is pseudoparenchymatous. In freshly expanded plants it is soft, thick and flesh-coloured; after exposure it shrinks considerably, changes to some shade of brown and often becomes rimose. Frequently it flakes away in irregular patches, and occasionally may peel from the fibrillose layer and assume a cupulate appearance around the base of the endoperidium (*G. velutinus* and *G. triplex*); indeed, it was the presence of such a structure that led to the erection of the latter species.

Endoperidium.

This structure is attached to the base of the exoperidium, and encloses the gleba, consisting of capillitium and spores. In texture it is membranous or papyraceous, consisting of numerous interwoven, partially gelatinized hyphae. The exterior is usually glabrous, but may be farinose (*G. Bryantii*), tomentose, covered with roughened particles, or even coated with a substance which gives to it an appearance as if coated with a heavy layer of chalk (*G. calceus*). The colour ranges from dingy white to dark umber-brown.

In those species in which the base of the exoperidium forms a small dome, the endoperidium is usually pedicellate, being attached at its base by a pedicel of varying length and thickness; in saccate plants it is usually sessile, attached by a broad base and partly surrounded by the saccate base of the exoperidium.

At the apex is a solitary stoma (sometimes two are present, as in *G. ellipticus*) through which the spores escape. This opening may be merely a poorly defined aperture, scarcely discernible from the endoperidium—when the species is said to possess a naked, indefinite mouth; or the stoma may be enclosed within a definite peristome, when the species is said to be peristomate. Should the peristome be regularly pleated or fluted it is said to be plicate; if silky and made up of innumerable parallel fibrils arranged radially around the stoma, it is said to be fibrillose. The significance of these differences will be made apparent under the section dealing with specific characters.

Gleba.—The whole of the tissues enclosed within the endoperidium is known as the gleba.

The spores are globose or less frequently subglobose, usually some shade of brown and, with one exception (*G. subiculosus*), verrucose or verrucose-echinulate. Their size and epispore markings are useful diagnostic characters.

The capillitium consists of innumerable fusiform or cylindrical, coloured, simple, continuous hyphae. They arise from the columella and less abundantly from the inner surface of the endoperidium. Their function is unknown, but they are supposed to aid in spore dispersion.

The columella arises from the base of the exoperidium (fibrillose layer) and is a continuation of the pedicel, when present. It is usually cylindrical, but may be clavate or even globose. Its presence in mature plants is often difficult to detect, but it may be readily seen when unexpanded plants are sectioned.

Specific Characters.

In genera containing numerous species it is customary to seek certain characters whereby the genus may be split into sections, and these in turn subdivided until at last only two or three closely related species remain together. Ultimately it should be possible on these lines so to arrange a key that each species is separable from the other; unfortunately this is often difficult owing to variation among closely related species breaking down artificial divisions that might otherwise be used.

The procedure in the preparation of such a key is to seek certain group characters sufficiently constant and well marked as to allow of group separation. In the genus *Gaster* these major or group characters have differed according as to the individualistic interpretation of their value. For example one worker has based his major divisions of the species on whether they are pedicellate or sessile; another on whether they are fornicate or saccate; a third on whether hygroscopic or non-hygroscopic. In the opinion of the writer these divisions are open to criticism because in all, closely related plants are widely separated.

He would first subdivide the genus into two main sections:

A. Mouth enclosed within a definite peristome.

B. Mouth naked (and usually indefinite).

And would further subdivide section A into

a. Peristome sulcate (Pl. ii, fig. 1);

b. Peristome fibrillose (Pl. ii, fig. 3);

thus grouping all species under three well-defined sections.

Mouth characters are sometimes spoken of as being sulcate or even, definite or indefinite, but these terms have in the past been so loosely applied as to have little value.

These three main sections may then be subdivided according to whether the exoperidium is hygroscopic or non-hygroscopic, and the endoperidium pedicellate or sessile. But these characters are by no means constant, and one often encounters plants difficult to place under one sub-section or the other.

All descriptions are original, save where otherwise stated, and have been drawn up from material examined by the writer. Details of the development and cytology of the epigaeal species *G. velutinus* have been worked out by the writer, and will be published elsewhere.

The writer is again indebted to Dr. J. B. Cleland, Adelaide University, for the loan of all specimens in his extensive herbarium; to Mr. C. C. Brittlebank, Victorian Department of Agriculture, for the loan of specimens in the Herbarium of the Science Branch of the Victorian Department of Agriculture; to Mr. L. Rodway, Government Botanist, Tasmania, for the loan of specimens from his collection; and to his friend Mr. H. Drake, of this Laboratory, for all photographs reproduced herein.

GEASTER Micheli.

Fries, *Syst. Myc.*, iii, 1829, p. 9.—*Gastrum* Pers., p.p., *Syn. Meth. Fung.*, 1801, p. 130.—*Cycloderma* Klotzsch, *Linnaea*, vii, 1832, p. 193.—*Plecostoma* Cda., *Anleit.*, 1842.

Peridium globose to acuminate, epigaeal or hypogaeal. Exoperidium of three layers, an external mycelial layer, a middle fibrillose layer, and an internal fleshy layer; at first closely investing the endoperidium, but distinct, splitting at maturity from the apex downwards into several stellate rays, which may be revolute or involute. Endoperidium pedicellate or sessile, membranous or papyraceous, thin, glabrous or variously roughened; dehiscing by a single apical orifice, which may be peristomate or naked.

Gleba of capillitium and spores; columella present or wanting; capillitium threads simple, long, apically acuminate, arising from the columella or inner wall of the endoperidium. Spores globose or subglobose, continuous, coloured, rough or smooth. Basidia sterigmate, 4-8 spored.

Habitat.—Solitary, in groups, or caespitose on the ground or vegetable debris in open pastures, under hedgerows or on the forest floor.

Distribution.—World-wide.

This genus contains about thirty species, of which twenty-three are found in this biological region. It is included in the Lycoperdaceae, a family containing in addition about six other genera.

Artificial Key to the Species.

A. Mouth peristomate.

Peristome sulcate.

Exoperidium not hygroscopic.

Endoperidium pedicellate.

Endoperidium smooth (or farinose, not roughened).

Peristome circular.

Base of the endoperidium smooth or striate

Base of the endoperidium plicate

Base of the endoperidium with a collar-

like ring

Peristome elliptical

Endoperidium roughened-verrucose.

Peristome concolorous

Peristome surrounded by a silky, differently

coloured zone

Endoperidium sessile or sub-pedicellate

Exoperidium hygroscopic.

Endoperidium pedicellate.

Spores 6-8 μ

Spores 4-5.5 μ

Endoperidium asperate

Endoperidium smooth

Endoperidium typically sessile

Peristome fibrillose.

Exoperidium not hygroscopic.

Endoperidium pedicellate.

Plants typically minute

Plants typically large

Endoperidium sessile.

Exoperidium externally felted-tomentose or

tomentose-strigose.

Plants large, 3-6 cm.

Plants small, 1.5-2 cm.

Exoperidium externally smooth, or almost so.

Spores smooth or nearly so

Spores verrucose-echinulate or verrucose.

Spores 2.5-3.5 μ

Spores 4-5 μ

Spores 7-8 μ

1. *G. pectinatus*

2. *G. plicatus*

3. *G. Bryantii*

4. *G. ellipticus*

5. *G. Hariotii*

6. *G. Berkeleyi*

5. (*G. Hariotii*)

7. *G. campester*

8. *G. Clelandii*

9. *G. Smithii*

10. *G. Drummondii*

11. *G. minus*

12. *G. Umbatus*

13. *G. velutinus*

14. *G. mirabilis*

15. *G. subiculosus*

16. *G. saccatus*

17. *G. triplex*

18. *G. australis*

Exoperidium hygroscopic.		
Endoperidium pedicellate	19.	<i>G. arenarius</i>
Endoperidium sessile		(<i>G. mammosus</i>)
B. Mouth naked.		
Exoperidium not hygroscopic.		
Endoperidium pedicellate.		
Exoperidium typically fornicate	20.	<i>G. fenestriatus</i>
Exoperidium revolute		(<i>G. rufescens</i>)
Endoperidium sessile	21.	<i>G. fimbriatus</i>
Exoperidium hygroscopic.		
Spores 6-7 μ	22.	<i>G. floriformis</i>
Spores 4-5 μ	23.	<i>G. simulans</i>

1. *GEASTER PECTINATUS* (Persoon) Lloyd. Plate iii, figs. 7, 8.

Geastreac, 1902, p. 15.—*Geastrum pectinatum* Pers., *Syn. Meth. Fung.*, 1801, p. 132.—*G. minimum* Chev., *Fl. Env. Paris*, i, 1826, p. 360.—*Geaster striatus*, Fr. p.p., *Syst. Myc.*, iii, 1829, p. 13.—*G. Schmidellii* Vitt., *Mon. Lyc.*, 1842, p. 157.—*G. calyculatus* Fcl. *Symb. Myc.*, 1870, p. 37.—*G. umbilicatus* Quel., *Mem. d. Soc. Em. d. Montbelliard*, ii, 1873, t. 3.

Plants at first globose, submerged, becoming superficial and expanded when 3-5 cm. across. Exoperidium split to about the middle into 5-12 subequal, acute rays which are expanded or sub-revolute; fleshy layer brown, unequally flaking away in irregular patches, leaving exposed the ochraceous fibrous layer; exterior covered with debris held by the adnate mycelial layer, which is persistent but tends to flake away; base concave.

Endoperidium pedicellate, subglobose, depressed-globose or urceolate, 1-2 cm. diam., brown or lead-coloured, often farinose, base tapering into the pedicel, striate or not, apophysis present or absent; pedicel slender, 3-6 mm. long. Peristome sulcate, prominent, narrowly conical, concolorous.

Gleba ferruginous; columella inevident; capillitium threads† tinted, fusiform, simple. Spores globose, 5-4-6-2 μ ; epispore dark umber, moderately and coarsely verrucose, reticulate.

Habitat.—Solitary or in groups on vegetable debris on the ground.

Distribution.—Britain; France; Austria; Sweden; North America; Australia; New Zealand.

New South Wales: * Milson Island, Hawkesbury River, Apl., 1913.

South Australia: * Black Hill, Adelaide, June, 1906, F. R. Zeitz (3 coll.); * Port Elliot, Aug., 1918, D. I. Cleland; * Glen Osmond, Dec., 1921; * Port Lincoln, May, 1923, Det. Lloyd No. 885 as *G. Schmidellii*; * National Park, May, 1923.

New Zealand: ** Dunedin, Otago, Aug., 1921, Miss H. K. Dalrymple; ** Otaki Forks, Wellington, Aug., 1922, E. H. Atkinson.

A darker, smaller form is by certain systematists separated as *G. Schmidellii*, but as all intermediate forms may occur in the same collection, separation, save at the extremes, is not practicable.

Two other species, *G. Bryantii* and *G. plicatus*, so closely resemble *G. pectinatus*, save in one or two minor characters, as to make separation a matter

† The capillitium threads are very similar in all the species examined, therefore they will not again be described save where they diverge from the normal.

* An asterisk indicates that the collection in question is in the herbarium of Dr. J. B. Cleland, Adelaide; and where the collection is preceded by an asterisk, but no collector given, it signifies that the collection was made by Dr. Cleland himself.

** A double asterisk preceding a collection indicates that the collection in question is in the herbarium of the writer.

of difficulty. For example, in one Australian collection there are plants which could be referred to *G. plicatus*, and others which could be placed under *G. Bryantii*. In a New Zealand collection one specimen could be placed under *G. plicatus*, the other under *G. pectinatus*. They are better considered as subspecies, and may be determined by the following characters:

Base of the endoperidium smooth or slightly striate *G. pectinatus*
 Base of the endoperidium plicate *G. plicatus*
 Base of the endoperidium with a well-defined collar or ring *G. Bryantii*

To these three subspecies the writer has added another, separated on account of the peculiar nature of the peristome, which is elliptical and not circular as in other species. In reality this structure consists of two peristomes merged so as to form a continuous opening. This is made apparent by the fact that two specimens in the collection each possess two distinct peristomes.

2. *GEASTER PLICATUS* Berkeley. Plate iii, fig. 9.

Ann. Nat. Hist., iii, 1839, p. 399.—*G. tenuipes* Berk., *Fl. Tas.*, ii, 1860, p. 264.—*G. biplicatus* Berk. et Curt., *Proc. Am. Acad. Arts and Sci.*, iv, 1860, p. 124.

This subspecies is separated from *G. pectinatus* solely on account of the plicate base of the endoperidium, for in all other respects it is identical.

Distribution.—India; Bonin Is.; Ceylon; New Caledonia; South Africa; Australia; Tasmania; New Zealand.

South Australia: * Fullarton, Adelaide, May, 1923.

Victoria: Grantville, J. T. Paul (Herb. Vic. Dept. Agr.).

New Zealand: ** Lake Papaetonga, Wellington, Aug., 1919, G.H.C.; ** Sandhills, Wairaroa, Wellington, Nov., 1919, E. H. Atkinson. (Both determined as above by Lloyd.)

3. *GEASTER BRYANTII* Berkeley. Plate iii, fig. 10.

Outl. Brit. Fung., 1860, p. 300.—*G. orientalis* Hazsl., *Grev.*, vi, 1877, p. 108.—*G. Kunzei* Wint., in Rabenh. *Krypt. Fl.*, i, 1884, p. 911.

Separated from *G. pectinatus* by the presence of a well-defined collar or ring around the base of the endoperidium immediately above the pedicel.

Distribution.—Britain; Sweden; North America; Australia.

New South Wales: * Hawkesbury River, July, 1912.

The endoperidium of *G. Bryantii*, and less frequently of *G. pectinatus*, is often quite covered with a farinose substance which may be readily rubbed away. This is not of specific value, however, for it may be present or absent in different specimens of the same collection.

4. *GEASTER ELLIPTICIS*, n. sp. Plate iii, fig. 11; Pl. vii, fig. 40.

Plants at first globose, submerged, becoming superficial and expanded when 2-3.5 cm. across. Exoperidium split to about the middle into 8-14 subequal, acute rays which are expanded or slightly involute; fleshy layer thin, more or less completely flaking away and leaving exposed the pallid tan fibrous layer; exterior covered with debris held by the adnate mycelial layer, which flakes more or less completely away; base concave.

Endoperidium pedicellate, subglobose or urceolate, 1-2 cm. diam., brown, smooth, shining, apophysis frequently present, base smooth; pedicel short. Peristome sulcate, prominent, conical, elliptical, up to 8 mm. long, sometimes two present on the same plant, concolorous or darker.

Gleba chocolate or almost black; columella wanting. Spores 4-6.8 μ , globose or subglobose; epispore dark brown, moderately and coarsely verrucose, reticulate.

Habitat.—Solitary or in groups on the ground under scrub.

Distribution.—Australia: * Pearson Island, Great Australian Bight, Jan., 1924. Type.

This species resembles the form of *G. pectinatus* known as *G. Schmidellii*, but is separated on account of the conspicuously elliptical peristome.

5. *GEASTER HARIOTII* Lloyd. Plate iv, fig. 12.

Mycological Notes, 1907, p. 311.

Plants at first globose, submerged, becoming superficial and expanded when up to 5 cm. across. Exoperidium split to about the middle into 7-9 subequal, acute, revolute or expanded rays; fleshy layer umber, becoming rimose; exterior covered with debris held by the adnate mycelial layer; base concave.

Endoperidium subpedicellate or sessile, up to 2 cm. diam., depressed-globose, dark umber, distinctly pitted and roughened but not warted nor tomentose. Peristome sulcate, conical, acute, darker in colour.

Gleba umber; columella not seen. Spores globose, 2.9-4.1 μ ; epispore umber, minutely, finely and closely verruculose.

Habitat.—Solitary on the ground.

Distribution.—Spain; Martinique; Porto Rico; Rio de Janeiro; Chile; Brazil; British Honduras; Dutch Guiana; Australia.

New South Wales: * Mummulgum, Dec., 1916.

The species is characterized by the pitted and roughened endoperidium, and especially by the minute, finely verruculose spores. The collection referred to above is placed under this species for it agrees closely in all particulars save that the specimen possesses a shortly pedicellate endoperidium. But as this is a variable character, it is doubtful whether it is of sufficient importance to separate this specimen, especially as the pedicel is such a short one. The minute spores so resemble those of *G. Hariotii* as described and figured by Coker (1924, p. 215) that the writer does not hesitate in determining it. Furthermore, Coker states that there is a collection in the Lloyd herbarium (under *G. Archeri*) from Victoria consisting of a pale form of this species.

†6. *GEASTER BERKELEYI* Massee.

Ann. Bot. iv, 1891, p. 79.

Plants at first globose, submerged, becoming superficial when expanded and 6-9 cm. across. Exoperidium split to about the middle into 7-9 unequal, acute, expanded or slightly revolute rays; fleshy layer brown, even, slightly rimose; exterior covered with debris held by the adnate, persistent mycelial layer; base concave.

Endoperidium pedicellate, ovate, up to 3 cm. diam., brown, coarsely papillate or granular; pedicel short, 3-5 mm. long. Peristome sulcate, prominent, conical, surrounded by a depressed, smooth, silky zone which is usually lighter in colour.

Gleba umber; columella short, globose. Spores globose, 5-6 μ diam.; epispore umber, acutely warted.

Habitat.—Solitary on the ground under trees.

Distribution.—England; South Australia.

† The writer has not seen specimens; the description given has been taken from Rea (1922) but rearranged so as to agree with the other descriptions included herein.

The species is separated from *G. pectinatus* by the rough endoperidium, from *G. Hariotii* by the larger spores, and from both by the depressed silky zone around the peristome.

7. *GEASTER CAMPESTER* Morgan. Plate ii, fig. 1; iii, figs. 13, 14; vii, fig. 41.

American Naturalist, xxi, 1887, p. 1026.—*G. pseudomammosus* P. Henn., *Hedw.*, xxxix, 1900, p. 54.—*G. asper* (Mich.) Lloyd, *Geastreae*, 1902, p. 18.

Plants small, globose, at first submerged, becoming superficial and expanded when up to 4 cm. across. Exoperidium split to about the middle into 7-12 acute, equal rays which are expanded when wet, involute when dry, folding over or under the endoperidium, or sometimes revolute; fleshy layer umber adnate, continuous or rimose; exterior covered with debris held by the closely adnate mycelial layer, becoming partly smooth; base umbilicate.

Endoperidium shortly pedicellate, depressed-globose or subglobose, up to 15 mm. diam., dingy white, tan or bay-brown, finely and closely asperate. Peristome conical, acute, seated on a depressed zone, which may be absent, frequently darker in colour.

Gleba umber; columella clavate, conspicuous. Spores globose, 6-8 μ ; epispore chestnut-brown, closely and sparsely verrucose.

Habitat.—Solitary or in groups on the ground.

Distribution.—Hungary; North America; Australia.

South Australia: *Kinchina, July, 1923, June, 1925, Aug. 1925; *Mannum, Apl., 1924; Hallett's Cove, Apl., 1924.

The exoperidium varies in different individuals of *G. campester* from being strongly hygroscopic to a flaccid, almost revolute condition. In fact, Lloyd (1902, p. 18) takes the species in his non-rigidae (non-hygroscopic) section. Coker (1924, p. 216), on the other hand, considers the species to belong to the hygroscopic section, a conclusion borne out by both his and Lloyd's illustrations.

The specific name *asper*, as used by Lloyd, was taken from a publication antedating the starting-point of modern nomenclature, Persoon, 1801, and so cannot be used.

The Australian species placed under the hygroscopic section of the group possessing sulcate peristomes so closely resemble one another as frequently to make separation a difficult matter. The section is usually subdivided according to whether species possess pedicellate endoperidia, but this character is of doubtful value, for specimens of the species included under the pedicellate section are occasionally sessile, and those placed under the sessile section frequently shortly pedicellate.

After extended examination of numerous collections the writer believes separation may be effected as in the key above (p. 75).

8. *GEASTER CLELANDII* Lloyd. Plate iv, fig. 15.

Mycological Notes, 1918, p. 794.

Plants globose, submerged, becoming superficial and expanded when up to 5 cm. across. Exoperidium split to about the middle into 8-10 acute, equal rays, which are expanded when wet, strongly involute when dry, folding over or under the endoperidium; fleshy layer umber, adnate, continuous, exterior covered with debris held by the adnate mycelial layer; base umbilicate.

Endoperidium shortly pedicellate, depressed-globose, up to 15 mm. diam., umber, coarsely and closely asperate. Peristome conical, acute, seated on a depressed zone, concolorous or darker.

Gleba ferruginous or umber; columella not seen. Spores globose or subglobose, 4-5.5 μ ; episore pallid brown, finely and closely verrucose.

Habitat.—Solitary or in small groups on the ground.

Distribution.—Australia.

Victoria: * Craigie, June, 1917, E. J. Semmens (Det. Lloyd, No. 360, as *G. Smithii*).

Western Australia: * Kalgoorlie, June, 1917, Mrs. A. F. Cleland. Type collection.

The species is separated from *G. campester* chiefly by the smaller spores, and from *G. Smithii* by the slightly larger spores and especially by the asperate endoperidium. The plant closely resembles *G. Drummondii*, but is separated by the smaller spores and pedicellate endoperidium.

9. GEAster SMITHII Lloyd. Plate ii, fig. 2; iv, fig. 16.

Geastrea, 1902, p. 21.

Plants small, at first submerged, becoming superficial and expanded when up to 4 cm. across. Exoperidium split to about the middle into 8-9 acute, equal rays, which are expanded when wet, involute when dry, folding in under the endoperidium; fleshy layer adnate, ferruginous, continuous, farinose; exterior covered with debris held by the adnate mycelial layer; base umbilicate.

Endoperidium shortly pedicellate, urceolate or pyriform, up to 15 mm. diam., pallid-tan or chestnut-brown, farinose, smooth, shining, papyraceous. Peristome flattened-conical or acutely conical, seated on a depressed zone, concolorous or darker.

Gleba ferruginous; columella inevident. Spores globose, 3.5-4.2 μ ; episore pallid ferruginous, finely and closely verrucose.

Habitat.—Solitary on the ground.

Distribution.—North America; Australia.

New South Wales: * Parramatta, July, 1912.

South Australia: * Overland Corner, Dec., 1912.

This species is considered by many mycologists to be a synonym of *G. umbilicatus*, but the subhygroscopic exoperidium and especially the smooth, shining, pedicellate endoperidium separate it. The flattened-conical peristome, which is made one of the chief characters of the species by Lloyd, is not of specific value for the same structure is present in occasional specimens of both *G. campester* and *G. Drummondii*.

The specimen from Parramatta exactly resembles the photograph presented by Lloyd. It differs from his description only in that the gleba is ferruginous and not black.

10. GEAster DRUMMONDII Berkeley. Plate iv, figs. 17, 18; vii, fig. 42.

Hooker's *Journal of Botany*, v, 1846, p. 1.—*G. striatulus* Kalchbr. et Cke., *Grav.*, ix, 1880, p. 3.—*G. Schweinfurthii* P. Henn., in *Engl. Bot. Jahrb.*, xiv, 1891, p. 361.—*G. involutus* Mass., *Grav.*, xxi, 1892, p. 3.

Plants small, globose, at first submerged, becoming superficial and expanded when up to 3 cm. across. Exoperidium split to about the middle into 8-10 acute, equal rays, which are expanded when wet, strongly involute when dry, folding over or under the endoperidium; fleshy layer umber, frequently farinose, adnate, continuous; exterior covered with debris held by the adnate mycelial layer, becoming partly smooth; base umbilicate.

Endoperidium sessile or occasionally shortly pedicellate, globose or depressed-globose, up to 10 mm. diam., dingy white or less frequently brown, finely asperate, often becoming smooth with age. Peristome conical, acute or flattened, seated on a depressed zone, which may be wanting, frequently darker in colour.

Gleba ferruginous; columella inevident. Spores globose or subglobose, frequently apiculate, 4.9-6.5 μ ; episore ferruginous, finely and sparsely verrucose.

Habitat.—In small groups on the ground.

Distribution.—Australia; Tasmania.

South Australia: * Encounter Bay, Aug., 1923 (Det. Lloyd, No. 888 as above); * Kinchina, June, 1925.

Victoria: Dimboola, June, 1890, F. M. Reader (Three collections; one determined by Lloyd as *G. striatulus*, another as *G. Drummondii*, the third was in a packet labelled *G. argenteus* Cke.). Herb. Vic. Dept. Agr.

Tasmania: Hobart, L. Rodway. Herb. Rodway, No. 1424.

Individual plants of this species may be sessile or shortly pedicellate; the pedicellate forms closely approach *G. Clelandii*, when the latter species may be separated by the more coarsely asperate endoperidium and smaller spores.

G. Drummondii closely resembles *G. umbilicatus* Fr. and is in fact separated only by the larger spores (those of *G. umbilicatus* being 3.5-4.2 μ). It would appear to replace the latter species in this biological area, for the writer has not seen Australian specimens he would consider to belong to *G. umbilicatus*.

11. *GEASTER MINUS* (Persoon), n. comb. Plate iv, fig. 23.

Geastrum quadrifidum var. *minus* Pers., *Syn. Meth. Fung.*, 1801, p. 133.—*G. quadrifidum* Nees, *Syst. Pilz. Schw.*, 1817, f. 128.—*G. minimus* Schw., *Syn. Fung. Carol.*, 1822, No. 327.—*Geaster fornicatus* Fr. p.p., *Syst. Myc.*, iii, 1829, p. 12.—*G. marginatus* Vitt., *Mon. Lyc.*, 1842, p. 163.—*G. Cesatii* Rabenh., *Bot. Zeit.*, ix, 1851, p. 628.—*G. granulosus* Fcl., *Enumerat.*, 1860, p. 41.—*G. coronatus* (Schaeff.) Schroet., p.p. *Krypt. Fl. Schw.*, iii, 1889.—*G. coronatus* (Schaeff.) Lloyd, *Geastreae*, 1902, p. 31.—*G. calceus* Lloyd, *Myc. Notes*, 1907, p. 311.—*G. juniperinus* McBr., *Mycologia*, iv, 1912, p. 85.

Plants at first globose, small, submerged, becoming erumpent and expanded when up to 3 cm. across. Exoperidium split to about the middle into 4-8 unequal, acuminate rays, which are commonly recurved or expanded, or may become fornicate by the mycelial layer splitting free from the fibrous layer, which together with the fleshy layer becomes arched (fornicate) but remains attached by the apices of the rays to the mycelial layer, the latter remaining attached to the substratum; fleshy layer brown, rimose, frequently flaking away in patches.

Endoperidium pedicellate, 3-12 mm. diam., obovate, elliptical or depressed-globose, variable in size and shape, pallid-white, tan, or bay-brown, sometimes umber, glabrous, farinose, or coated with closely adnate glistening particles, giving to the whole a glistening appearance; pedicel up to 3 mm. long, frequently with an apical apophysis. Peristome variable, typically conical and fibrillose-fimbriate, frequently silky-fibrillose, sometimes almost indefinite and plane, seated on a definite silky area outlined by a depressed groove, or indefinite when the groove is scarcely apparent or absent.

Gleba ferruginous; columella inevident. Spores globose, 4.5-5.8 μ ; episore fuscous or umber, finely, sparsely and irregularly verrucose.

Habitat.—Solitary, in groups or caespitose on the ground.

Distribution.—France; Austria; Hungary; Sweden; North America; Jamaica; Japan; Ecuador; Australia; New Zealand.

South Australia: * Berri, Jan., 1921; * Beaumont, Adelaide, May, 1922; * Monarto South, July, 1922; * Fullarton, Adelaide, June, 1922; May, 1923; * Pt. Lincoln, May, 1923; * Glen Osmond, June, 1923; * Marble Range, West Coast, June, 1923; * Kinchina, Nov., 1924, June, 1925; * Pearson Island, Great Australian Bight, Jan., 1922; * Mt. Wedge, Eyre's Peninsula, Aug., 1925.

Victoria: Dimboola, June, 1890, F. M. Reader (Herb. Vic. Dept. Agr.).

New Zealand: ** Sandhills, Levin, Wellington, Nov., 1919, S. A. Cunningham;

** Dunedin, Otago, Miss H. K. Dalrymple, May, 1922; ** Ashburton, Canterbury, Aug., 1925, J. C. Neill, D. W. McKenzie.

This is the most variable species of those Australasian Geasters examined by the writer. Specimens vary in size from minute plants 5 mm. across to forms over 4 cm. across. The exoperidium may be revolute (*G. minimus*), fornicate (*G. coronatus*), hygroscopic (*G. arenarius*), or saccate (when the plants resemble small forms of *G. triplex*). The endoperidium may be pedicellate or almost sessile, and may be smooth, covered with minute glistening particles, or with a thick white incrustation (*G. calceus*). The peristome may be plane, conical or obscure, and may be seated on a flattened silky zone outlined by a depressed groove, or the zone may be inevident, the groove in such cases being absent. The peristome may be fibrillose-silky, distinctly fimbriate-lacerate or almost indefinite. The spores, too, vary in size and degree of roughness, and two types may be recognized, one averaging 4.9-5.8 μ , the other 3.5-4.2 μ . The collections from Beaumont, Fullarton and Kinchina above are of the latter type.

Many names have been given these various forms but it is not practicable to separate one from another owing to the difficulty in defining the limits of each. Possibly the form known as *G. arenarius* is worthy of a distinct name, although even with this form plants occur which are difficult to place.

The fornicate and revolute forms have hitherto been considered as distinct species, the former being known as *G. coronatus*, the latter as *G. minimus*; but Coker (1924, p. 206) has shown that the fornicate form is but a condition of the other, for he found all connecting stages growing together.

The name for this species is taken from *Gastrum quadrifidum* var. *minus*, for in his publication Persoon clearly set out the differences between this and *G. fenestriatus* (= *G. fornicatus* Auctt.); see the note under the latter species. Furthermore, the specific name *coronatus* is preoccupied; see below, under *G. limbatus*.

12. GEAETER LIMBATUS Fries. Plate ii, fig. 5; iv, figs. 19-22; vii, fig. 43.

Syst. Myc., iii, 1829, p. 15.—*Gastrum coronatus* Pers. p.p., *Syn. Meth. Fung.*, 1801, p. 132.

Plants at first globose, submerged, becoming superficial and expanded when 3-6 cm. across. Exoperidium split to about the middle into 7-10 unequal, acute rays, which are expanded and revolute, or sometimes partially involute; fleshy layer bay-brown or ferruginous, continuous or rimose, frequently farinose; exterior covered with debris held by the persistent, adnate mycelial layer, in old specimens frequently partially flaking away; base concave or plane.

Endoperidium pedicellate, depressed globose, obovate or sub-pyriform, glabrous when old, farinose when young, grey or weathered to umber, up to 1.5 cm. diam. Peristome depressed, acute, fibrillose, surrounded by a pallid or concolorous fibrillose or silky zone.

Gleba chocolate; columella almost obsolete. Spores globose, 4-9.5 μ ; episporium fuscous, acutely, densely and coarsely warted, opaque.

Habitat.—In small groups on the ground.

Distribution.—Britain; Tyrol; Hungary; North America; East Africa; Australia; New Zealand.

New South Wales: * Murwillumbah, Apl., 1916.

South Australia: Murray Bridge, Apl., 1889, J. G. O. Tepper (Herb. Vic. Dept. Agr.); * Mt. Lofly, July, 1914; * Glen Osmond, 1921; * Adelaide, 1921; * Fullarton, Dec., 1922, Feb., 1923; * Beaumont, May, 1923, Apl., 1924; * Encounter Bay, Jan., 1924; * Kinchinn, Nov., 1924, Jan., June, 1925; Hallett's Cove, Apl., 1924.

New Zealand: ** Sandhills, Levin, Wellington, Oct., 1919, E. H. Atkinson; ** Wadestown, Wellington, Apl., 1923, J. C. Neill; ** Ashburton, Canterbury, Aug., 1925, J. C. Neill, D. W. McKenzie; ** Kelburn, Wellington, Nov., 1925, G.H.C.

The plant from this biological region is the same as that referred to *G. limbatum* by nearly all European mycologists, but differs from the plant described by Coker (1924) as occurring in North America, by the somewhat roughened exoperidium and especially by the persistent, universal mycelial layer. His plant has the exterior free or almost free from debris, is attached to the substratum by a central basal mycelial cord and not generally as with our plant. Further, the mycelial layer in the American plant frequently becomes separated from the fibrous layer and assumes a pseudo-fornicate appearance. It is obvious that Coker is dealing with a plant that is not *G. limbatum* Fr. but is either undescribed, or, what is probable, a sub-pedicellate form of *G. triplex*, a supposition strengthened by the epigeal habit.

The definite fibrillose peristome, large and coarsely warted spores and evident pedicel are the characters of *G. limbatum*.

Lloyd has confused *G. limbatum* with *G. rufescens*, for he considers the former is separated from the latter only by the absence of a well-defined pedicel. *G. rufescens* has not been found in this biological region, although Lloyd claims a small form is present; this he has determined as *G. Readeri*. It is evident from a specimen so determined in Dr. Cleland's collections that he has mistaken a small form of *G. limbatum* for *G. Readeri*, which, according to Coker (1924, p. 185), who has examined type collection specimens, is a synonym of *G. velutinum*, a plant widely separated from *G. limbatum*.

13. GEASTER VELUTINUS Morgan. Plate v, figs. 26, 27.

Journ. Cin. Soc. Nat. Hist., xviii, 1895, p. 38.—? *G. javanicum* Lev., *Ann. Sci. Nat.*, v, ser. iii, 1846, p. 161.—? *G. dubius* Berk., *Journ. Linn. Soc.*, xiv, 1875, No. 130.—*Cycloderma ohioensis* Cke., *Grev.*, xi, 1883, p. 95.—*Geaster Readeri* Cke. et Mass., *Grev.*, xvi, 1888, p. 73.—*G. Lloydii* Bres., *Myc. Notes*, 1901, p. 50.

Plants ovate, bluntly pointed, superficial, attached to the substratum by a central basal cord, becoming expanded when 3-6 cm. across. Exoperidium saccate, split to about the middle into 5-8 expanded or revolute, broad, thick, subequal rays which when dry frequently split into two thin fibrous and persistent layers; fleshy layer flesh-coloured, umber and rimose when dry; exterior free from debris, covered with close, brown, felted tomentum; base convex, marked with a prominent umbilical scar.

Endoperidium sessile; globose or depressed-globose, up to 2 cm. diam., brown or pallid-tan, minutely furfuraceous or tomentose, lower portion enclosed by the saccate base of the exoperidium. Peristome small, broadly conical, fibrillose, seated on a depressed silky zone, which may be wanting, concolorous or pallid.

Gleba umber; columella cylindrical; capillitium threads occasionally branched near their apices. Spores globose, 4.1-4.5 μ ; epispore fuscous, finely and sparsely echinulate, reticulate.

Habitat.—Epigaeal; crowded in small groups on vegetable debris, or frequently on decaying wood on the forest floor.

Distribution.—North America; Cuba; Porto Rico; Brazil; Africa; Gold Coast Colony; Australia; New Zealand.

New South Wales: * Kangaroo Valley, June, 1919.

South Australia: * Kinchinnah, July, 1923.

New Zealand: ** Weraroa, Wellington, Aug., 1919, G.H.C. (Det. Lloyd as *G. javanicus*); ** Botanical Gardens, Wellington, July, 1922, June, 1925; ** Weraroa, May, 1923, J. C. Neill. (3 collections).

This is the most abundant species in New Zealand, but is apparently rare in Australia. According to Lloyd (*Myc. Notes*, 1907, p. 315), *G. javanicus* Lev. is a dark-coloured form. If so, this name must replace *velutinus*, but in the absence of authentic specimens of *G. javanicus* for examination, the writer is not disposed to make the change. *Cycloderma ohienensis* was based on unopened plants, so the specific name *ohienensis* cannot replace *velutinus*. *G. dubius*, also, was based on unopened plants, and is doubtfully considered a synonym of this species.

As a result of the examination of type collection material, in the herbarium of the New York Botanic Garden, Coker (1924) has shown that *G. Readeri* is also a synonym, and not, as Lloyd (1905) claims, a synonym of *G. rufescens*. Lloyd (1903, p. 155) claims that *G. radicans* Berk. is a fornicate condition of this species, but according to Coker the spores are different, although the plants agree in all other respects, especially in the central rooting base and consequent epigaeal habit.

A natural section of the genus consists of those species in which the immature plants are at all stages epigaeal. The species are all related, and much confusion has arisen as to the specific characters by which they might be delimited. The writer has found that separation is possible as in the above key (page 75).

In addition, *G. mirabilis*, *G. subiculosus* and *G. velutinus* are further characterized in that they grow on a dense mycelial subiculum; this is not so apparent with *G. velutinus*.

14. GASTER MIRABILIS Montagne. Plate v, fig. 28.

Ann. Sci. Nat., iv, ser. iii, 1855, No. 595.—*G. papyraceus* Berk. et Curt., *Proc. Am. Acad. Arts and Sci.*, iv, 1858, p. 124.—*G. lignicola* Berk., *Journ. Linn. Soc. Bot.*, xviii, 1881, p. 386.—*G. caespitosus* Lloyd, *Myc. Notes*, 1907, p. 315.

Plants, small, subglobose, or obovate, umbonate, superficial, attached by a central basal cord, becoming tardily expanded when up to 2 cm. across. Exoperidium saccate, split to about the middle into 5-7 broad, bluntly pointed rays; fleshy layer flesh-colour, drying bay-brown, continuous, adnate; exterior free from debris, brown, strigose-tomentose; base convex, with a prominent basal umbilical scar.

Endoperidium sessile, subglobose, pallid-tan, finely tomentose or glabrous, lower third enclosed by the saccate base of the exoperidium. Peristome conical, silky, fibrillose, concolorous or darker, frequently seated on a depressed zone.

Gleba umber; columella inevident. Spores globose, 3-4 μ ; epispore fuscous, minutely and closely verruculose.

Habitat.—Solitary or more frequently densely caespitose upon a pallid mycelial subiculum on decaying wood or other vegetable debris on the forest floor; epigaeal.

Distribution.—North America; Jamaica; Brazil; Cuba; Africa; Ceylon; Bonin Is.; Japan; Australia.

Queensland: Rockingham. Type of *G. lignicola*, in Kew Herb.

The writer has not seen Australian specimens, and so has drawn up the description of this species from North American material kindly donated by Dr. Coker (No. 7331).

Coker (1924, p. 190) has examined the type material of *G. lignicola* at Kew and considers it to be the same as *G. mirabilis*, for it appears to differ only in that the exterior of the exoperidium is nearly smooth, and not so distinctly strigose-tomentose as the North American specimens.

The species is separated from *G. velutinus* by the small size, caespitose habit and strigose-tomentose exterior. The spores are slightly larger but are more finely marked.

15. *GEASTER SUBICULOSUS* Cooke and Massee.

Grevillea, xvi, 1887, p. 16.

Coker (1924), who has examined the types at Kew, states:

"The best specimen shows a spore sac [endoperidium] about 7 mm. thick, dark brown; peristome not outlined by a groove or ridge but paler and fibrous. Surface of buttons [immature plants] minutely spongy, of older plants nearly glabrous. Largest button 1.1 cm. thick. Subiculum white, membranous. Spores spherical, practically smooth, some finely dotted, 3.3-8 μ ".

He refers to this species a collection from Jamaica in which the spores are smooth, globose, 2-3 μ .

Habitat.—Crowded on a white mycelial subiculum on the surface of rotting vegetable debris; epigaeal.

Distribution.—Jamaica (?); Australia.

Australia: Trinity Bay. Type in Kew Herbarium. *? New South Wales: Forbes, Aug., 1915.

The writer would refer a specimen in Dr. Cleland's possession to this species. The spores are 2.9-3.7 μ , globose, and delicately verruculose under the oil immersion, smooth under a lower power. The exterior is buff-coloured and spongy-tomentose; the peristome is seated on a depressed area and is scarcely fibrillose and almost plane.

The species is characterized by the almost smooth spores, a character not possessed by any other Australasian species. Lloyd (1905, p. 20) considers it to be a form of *G. mirabilis*.

16. *GEASTER SACCATUS* Fries. Plate vii, fig. 44.

Syst. Myc., iii, 1829, p. 16.

Plants superficial, ovate, pointed or umbonate, attached by a basal mycelial cord, becoming expanded when 2-3 cm. across. Exoperidium saccate, split to about the middle into 5-9 pliable, thin, expanded or revolute, equal, acute rays; fleshy layer brown, adnate, frequently rimose; exterior smooth, free from debris; base concave or plane, sometimes convex, with a prominent umbilical scar.

Endoperidium sessile, up to 1.5 cm. diam., globose, glabrous, brown, partially enclosed by the saccate base of the exoperidium. Peristome fibrillose, almost plane, concolorous or pallid, even, seated on a small depressed silky zone.

Gleba umber; columella indistinct. Spores globose, 2.3-3.7 μ ; epispore umber, finely and closely verruculose, reticulate.

Habitat.—Solitary or in small groups on the ground; epigaeal.

Distribution.—Britain; Europe; North and South America; Bahamas; Jamaica; Australia; Tasmania.

New South Wales: * National Park, July, 1916 (Det. Lloyd, No. 358, as above);

* June, Oct., 1917 (Det. Lloyd, No. 472, as *G. arenarius*).

Victoria: Smedley Park, Melbourne, Apl., 1884, F. M. Reader; Myrning, 1900, D. McAlpine. (Both in Herb. Vic. Dept. Agr.)

Tasmania: Hobart, L. Rodway (Herb. Rodway, No. 1422).

Opinions differ as to what plant Fries described as *G. saccatus*, and specimens in different herbaria may be found under different names. For example one of Dr. Cleland's collections determined by Lloyd as *G. arenarius*, the writer has placed under *G. saccatus*; others named by Lloyd as *G. saccatus* the writer has placed under *G. triplex*, *G. australis* and *G. minus* respectively.

The writer would follow certain European mycologists in considering the species to be characterized by the fibrillose peristome, and exoperidium externally free from debris; and in addition would add the presence of a prominent basal umbilical scar (showing the plant to be epigaeal) and spores 2.3-3.7 μ in diameter. As so defined the species would appear to have a sparse though wide distribution. Certain plants approach *G. fimbriatus* in the possession of a less definite peristome and tendency for the mycelial layer to hold debris upon the exterior of the exoperidium.

17. *GEASTER TRIPLEX* Junghuhn. Plate ii, figs. 3, 4; v, figs. 29-31; vi, fig. 32; vii, fig. 45.

Tijdschr., vii, 1840, p. 287.—*G. lageniformis* Vitt., *Mon. Lyc.*, 1842, p. 160.—*G. Archeri* Berk., *Fl. Tas.*, ii, 1860, p. 264.—*G. Michelianus* W. G. Sm., *Gard. Chron.*, 1873, p. 608.—*G. Kalchbrenneri* Hazsl., *Verh. K. K. Zool. Bot. Ges. Wien*, 1876, p. 76.—*G. vittatus* Kalchbr., *Ung. Akad. d. d. Wiss.*, xvii, 1884, p. 10.—*G. coriaceus* Col., *Trans. N. Z. Inst.*, xxii, 1890, p. 451.—*G. Englerianus* P. Henn., *Engl. Bot. Jahrb.*, xiv, 1891, p. 361.—*G. Morganii* Lloyd, *Myc. Notes*, 1901, p. 80.—*G. violaceus* Lloyd, *Myc. Notes*, 1907, p. 310.

Plants superficial, ovate, pointed, becoming expanded when 2-12 cm. across. Exoperidium split to about the middle into 5-8 equal, narrowly acuminate rays, which are expanded or revolute; fleshy layer umber, rimose, frequently partially flaking away, sometimes a small portion persisting as a small collar around the base of the endoperidium; exterior free from debris, bay-brown or tan-coloured, glabrous, usually marked with numerous longitudinal striae; base plane, with a prominent umbilical scar.

Endoperidium sessile, 0.5-2.5 cm. diam., depressed-globose or almost pulvinate, bay-brown or umber, glabrous, finely pitted or smooth, membranous. Peristome fibrillose, mammose, seated on a broad, depressed, silky, pallid zone which is usually outlined by an upraised margin.

Gleba ferruginous to umber; columella clavate or indistinct. Spores globose, 4.1-4.9 μ diam.; epispore almost black, finely and closely verrucose, reticulate.

Habitat.—In groups on decaying vegetable debris; epigaeal.

Distribution.—Britain; Europe; North and South America; Australia; Tasmania; New Zealand.

Victoria: Smedley Park, Melbourne, Apl., 1884, F. M. Reader (Herb. Vic. Dept. Agr.).

New South Wales: * Milson Island, Hawkesbury River, July, 1912 (Det. Lloyd, No. 359, as above); * Terrigal, June, 1914; * Neutral Bay, Sydney, June, 1914 (3 coll.); * Dorriggo, Jan., 1918 (immature plants); * twenty miles north of Baradine, Oct., 1918; * National Park, May, 1919 (2 coll.).

South Australia: * Overland Corner, Dec., 1912.

Lord Howe Island: * July, 1911, W. W. Watts.

Tasmania: Hobart, L. Rodway (Herb. Rodway, No. 1423).

New Zealand: ** Weraroa, Wellington, Aug., 1919, G.H.C. (det. Lloyd as *G. Englerianus*), (2 coll.), May, 1923, J. C. Neill; ** Dunedin, Otago, May, 1922, Miss H. K. Dalrymple; ** Whakatikei Forest Reserve, Wellington, June, 1923, J. C. Neill.

The species is characterized by the acuminate apices of the expanded rays, and glabrous, usually striate exterior of the exoperidium, the base of which is marked with a prominent umbilical scar. In typical plants the peristome is very characteristic, the large depressed silky zone surrounding the large, fimbriate-fibrillose mouth readily separating it from *G. saccatus*; but with the small forms the peristome characters merge with those of the latter, in which case separation is possible only upon the larger, more coarsely verrucose, very dark spores of *G. triplex*.

G. triplex closely resembles *G. australis*, but may be separated by the smaller spores, long pointed apex of the immature plant, and darker colour of the endoperidium.

G. Archeri was described as a species possessing a sulcate mouth; Lloyd (1902, p. 20), who first discussed it under the name *G. Morganii*, which he later (1905) showed was a synonym, noted its resemblance to *G. lageniformis* (= *G. triplex*), but claimed it differed in the presence of the sulcate mouth. Later (1905, p. 19) he stated it was *G. saccatus* in all particulars save the indefinite sulcate mouth. Coker (1924) described the peristome (of *G. Morganii*) as being rather vaguely outlined, consisting of a narrowly conical papilla (typically) with the sides crumpled toward the tip or almost all over, forming a pseudo-sulcate peristome with lacerated tip. He considered the species to be related to *G. triplex*, and claimed on account of several minor characters (of no specific import) that *G. Morganii* was distinct from *G. Archeri*. The writer has examined specimens of a dozen plants collected within a radius of 30 cm. (Whakatikei Forest Reserve). The major number are *G. triplex*, but four might be considered as typical specimens of *G. Archeri*, possessing the same pseudo-sulcate peristome. Thus as both forms occur in the same collection (and attached to the same mycelial mass) it is obvious that *G. Archeri* is but a condition of *G. triplex*, in which the normally fibrillose peristome has become accidentally pleated.

G. vittatus was based on plants possessing longitudinal striae on the exterior of the exoperidium. As this is a condition common to plants both of *G. triplex* and *G. australis*, it is obvious that it cannot be considered of specific value.

G. Englerianus was erected on a dark-coloured form, a character of no specific value, for both light and dark coloured plants are frequent in the same collection.

G. violaceus was erected on the purple colour of the endoperidium. In one collection from Australia, one specimen has the endoperidium a dull purple, the other being brown; both are identical in all other respects, thus showing of what slight value colour is as a specific character.

G. lageniformis is a form with a somewhat larger and more silky zone surrounding the peristome, and rays which are thinner and more acute than the typical form of *G. triplex*; in all other respects it is identical.

18. *GEASTER AUSTRALIS* Berkeley. Plate vi, fig. 33; vii, fig. 46.

Fl. Tas., ii, 1860, p. 265.

Plants superficial, at first ovate and acuminate, becoming expanded when up to 7 cm. across. Exoperidium saccate, split to about the middle into 6-8 broad, equal, acuminate rays, which are tardily expanded or with the tips revolute; fleshy layer bay-brown or chestnut-brown, adnate, continuous when fresh, becoming rimose; exterior free or partially free from debris, ochraceous, glabrous; base plane, convex or occasionally umbilicate, marked with a prominent umbilical scar.

Endoperidium sessile, up to 2 cm. diam., ochraceous or tan-coloured, glabrous, smooth. Peristome fibrillose, mammosc, seated on a broad, silky, slightly depressed, concolorous zone, which is occasionally outlined by a slightly raised margin.

Gleba ferruginous; columella ineident. Spores globose, 7.4-8.3 μ ; epispore tinted, finely and sparsely verrucose-echinulate.

Habitat.—In small groups on the ground; epigaeal.

Distribution.—Australia; Tasmania.

Victoria: Smedley Park, Melbourne, Apl., 1884, F. M. Reader; Wandin, Nov., 1915, C. C. Brittlebank. (Both in Herb. Vic. Dept. Agr.).

South Australia: Murray Bridge, Apl., 1889, J. G. O. Tepper (Herb. Vic. Dept. Agr.); * National Park, Aug., 1921 (doubtfully det. by Lloyd, No. 779, as *G. simulans*), Sept., 1922; * Adelaide, 1924 (immature plants); * F. R. Zeitz coll.

New South Wales: * Bumberry, Sept., 1916 (det. Lloyd, No. 215, as *G. saccatus*); * Manildra, Oct., 1916; * Myall Lakes, May, 1919; * Kendall, Aug., 1919.

This species approaches *G. triplex*, having practically the same habit, peristome characters and smooth exterior to the exoperidium. It differs in the much larger spores and ochraceous endoperidium. As a rule plants are not so free from debris as are those of *G. triplex*, but they have the same epigaeal habit, as is evidenced by the presence of the prominent umbilical scar at the base.

19. *GEASTER ARENARIUS* Lloyd. Plate v, figs. 24, 25.

Geastreac, 1902, p. 28.

This subspecies is a hygroscopic form of *G. minus*, differing only in its shorter pedicel and hygroscopic exoperidium, the rays of which, when dry, fold over or under the endoperidium.

Habitat.—In small groups on sandy soil.

Distribution.—North America; Australia.

New South Wales: * Coolamon, May, 1918 (det. Lloyd, No. 474, as above).

South Australia: * Wirrealpa, Aug., 1921; * Monarto South, Sept., 1921; * Ooldea, Aug., 1922.

In two of these collections the spores are the same size as the types, being 3.2-3.8 μ ; in the others they are the size of the typical form of *G. minus*, 4.5-5.8 μ . This variation also occurs with *G. minus*, for in many collections the spores are smaller, being the same size as those of the type of *G. arenarius*. It has been considered inadvisable to separate these smaller spored forms, for they are identical in all other particulars with the larger spored forms.

20. *GEASTER FENESTRIATUS* (Persoon), n. comb. Plate vi, figs. 34, 35.

Gastrum quadrifidum var. *fenestriatum* Pers., *Syn. Meth. Fung.*, 1801, p. 133.—*G. quadrifidum* DC., p.p., *Fl. Fr.*, ii, 1815, p. 267.—*Geaster fornicatus* Fr., p.p., *Syst. Myc.*, iii, 1829, p. 12.—*G. fenestriatus* (Batsch) Lloyd, *Myc. Notes*, 1901, p. 70.—*G. marchicus* P. Henn., *Nat. Pflanzenfam.*, I³², 1901, p. 321.—*G. fornicatus* (Huds.) Fr. Auctt.

Plants globose, at first submerged, becoming superficial and expanded when 3-6 cm. across. Exoperidium split to about the middle into 4-5 rays; the outer (mycelial) layer remaining as a hollow cup in the substratum, the inner fibrous and fleshy layers becoming strongly fornicate, attached at tips to the basal cup, rays firm, thick, brown; fleshy layer brown, partly flaking away from old specimens; base strongly convex.

Endoperidium pedicellate, up to 3 cm. diam., depressed-globose, urnulate, with a constricted ring-like apophysis above the pedicel, ferruginous, finely pubescent. Mouth naked, conical or mammiform, tubular, apex fibrillose, or lacerate.

Gleba ferruginous; columella long-elliptical. Spores globose, 4.2-4.9 μ ; epispore umber, moderately and finely verrucose, reticulate.

Habitat.—Solitary on vegetable debris on the ground.

Distribution.—Britain; Hungary; Russia; North America; Mauritius; Algeria; South Africa; Hawaii; Australia.

South Australia: *Pearson Island, Great Australian Bight, Jan., 1923 (2 collections); *Overland Corner, Dec., 1912.

This species is characterized by the fornicate exoperidium, and is on this account readily recognized, being liable to confusion (in this particular) only with *G. minus* and *G. radicans*, but is separated from these two by the naked mouth. This species has in Europe regularly been confused with *G. minus*; certain mycologists refer it to *G. fornicatus* (Huds.) Fr., a name which is untenable, for as Lloyd has frequently and freely pointed out, Fries included both this and *G. minus* in his species, extending his description and citations to cover both. Persoon, however, clearly recognized the differences between the two, for he separated the species discussed above as *Gastrum quadrifidum* var. *fenestriatum*, the other as *G. quadrifidum* var. *minus*. His varietal names are therefore used for the two species under discussion.

Occasionally plants do not become fornicate, but remain in the expanded condition; in such cases the naked mouth serves to characterize them.

GEASTER RUFESCENS (Persoon) Fries.

Syst. Myc., iii, 1829, p. 18.

Lloyd (1905, p. 22) claims that a small form of this species, *G. Readeri*, is present in Australia, but the writer believes he is confusing this with a small form of *G. limbatus*, for one collection so determined is *G. limbatus*. As has been shown, *G. Readeri* is a synonym of *G. velutinus*, a plant widely separated from *G. rufescens*.

21. *GEASTER FIMBRIATUS* Fries. Plate vi, fig. 36.

Syst. Myc., iii, 1829, p. 16.—*G. tunicatus* Vitt., *Mon. Lyc.*, 1842, p. 118.

Plants globose, submerged, becoming expanded when up to 3 cm. across. Exoperidium saccate, split to about the middle into 6-8 unequal, flaccid, bluntly pointed rays which are tardily expanded or with the tips only revolute; fleshy

layer bay-brown or umber-brown, continuous, adnate; exterior wholly covered with debris held by the adnate mycelial layer, which may partially flake away upon weathering; base convex, plane or concave.

Endoperidium sessile, 0.5-1 cm. diam., depressed-globose, dingy-white to umber-brown, glabrous, smooth. Mouth either an indeterminate aperture with fibrous and lacerated margin, or defined by a slightly depressed, concolorous or lighter zone; sometimes approaching the fibrillose condition.

Gleba umber; columella inevident. Spores globose, 3.3-4.5 μ ; epispore fuscous, closely and finely verrucose, reticulate.

Habitat.—In small groups on the ground; hypogaeal.

Distribution.—Britain; Italy; Austria; France; North America; Australia; Tasmania.

Victoria: * Staughton Vale, Brisbane Range, Nov., 1923.

New South Wales: * Manildra, Oct., 1916 (det. Lloyd, No. 213, as *G. saccatus*, "pigmy form").

South Australia: * Mt. Dutton Bay, West Coast, May, 1923; * Fullarton, Adelaide, 1924; * Kinchina, June, Aug., 1925.

The species is characterized by the small size, indefinite mouth and persistent mycelial layer. Occasionally in the same collection are encountered plants with a mouth appearing peristomate and fibrillose. Such plants make delimitation difficult, and with this species more so in that the spores are of two types, certain collections possessing spores 3.3-3.7 μ in diameter, others, apparently identical in all other respects, possessing spores 3.7-4.5 μ . The hypogaeal habit is a character which should aid the student in the diagnosis of the species, for those species which extreme forms resemble—*G. saccatus* and *G. triplex*—are epigaeal, a character which is made apparent in herbarium specimens by the prominent umbilical scar at the base of the exoperidium, a feature absent from *G. fimbriatus*.

22. *GEASTER FLORIFORMIS* Vittadini. Plate ii, fig. 5; vi, fig. 37; vii, figs. 38, 47.

Mon. Lyc., 1842, p. 167.—*G. delicatus* Morgan, *Am. Nat.*, xxi, 1887, p. 1028.—*G. hungaricus* Hollos, *Gast. Hung.*, 1903, p. 64.

Plants at first globose, submerged, becoming superficial and expanded when 2-6 cm. across. Exoperidium split to about the middle into 7-12 subequal, narrow, acute rays which are expanded when wet, strongly involute when dry, then folding completely over (rarely under) the endoperidium; fleshy layer adnate, smooth, umber, rimose when old; exterior at first covered with debris held by the closely adnate mycelial layer, soon flaking away and leaving exposed the glabrous, ochraceous or brown fibrous layer; base strongly umbilicate.

Endoperidium up to 1.5 cm. diam., sessile, depressed-globose, minutely furfuraceous, glabrous when old. Mouth naked, indefinite, conical or more frequently plane, irregularly torn and apically fibrillose in old specimens.

Gleba umber; columella small, cylindrical. Spores globose, or subglobose, 5.4-7.4 μ ; epispore dark brown, closely and coarsely warted.

Habitat.—In groups on the ground; hypogaeal.

Distribution.—Hungary; North America; South Africa; Australia; New Zealand.

Victoria: Dimboola, June, 1890, F. M. Reader; Melbourne, D. McAlpine, 1900. (Both collections in Herb. Vic. Dept. Agr.)

New South Wales: * Bibbenluke, Mar., 1913; * Forbes, Aug., 1915 (det. Lloyd, No. 362, as above).

South Australia: * Port Elliot, Aug., 1918, D. I. Cleland; * Adelaide, July, 1914; * Ooldea, Aug., 1922; * Aldinga Bay, Nov., 1923; * Kinchina, Nov., 1924.

New Zealand: ** Masterton, Wellington, May, 1923; ** Dunedin, Otago, Miss H. K. Dalrymple, May, 1923; ** Ashburton, Canterbury, Aug., 1925, J. C. Neill, D. W. McKenzie.

The species is characterized by the hygroscopic exoperidium, sessile endoperidium and naked, indefinite mouth. The large spores are also a feature, although they are not constant in all collections, for in several the writer has examined they are somewhat smaller than the normal, averaging $5.4-6.5 \mu$. The mouth does not at any time approach the fibrillose condition, so that even with old specimens there is no difficulty in determining the section to which this species belongs.

23. *GEASTER SIMULANS* Lloyd. Plate vii, figs. 39, 48.

Lyc. Aus., 1905, p. 17.

Plants globose, submerged, becoming superficial and expanded when up to 4 cm. across. Exoperidium split to about the middle into 7-8 unequal, acute rays, which are expanded when wet, involute when dry, folding over or usually under the endoperidium, sometimes drying partially expanded; fleshy layer thick, adnate, umber, rimose or continuous; exterior at first covered with debris held by the adnate mycelial layer, usually flaking away, leaving exposed the ochraceous or bay-brown fibrous layer; base strongly umbilicate.

Endoperidium sessile, depressed-globose, up to 1.5 cm. diam., glabrous, ochraceous. Mouth a minute, indefinite, plane aperture, lacerate or fibrillose when old, slightly wrinkled or folded.

Gleba ferruginous; columella inevident. Spores globose, $4.5-2 \mu$; epispore fuscous, finely, evenly and closely verruculose, reticulate.

Habitat.—Solitary or in small groups on the ground.

Distribution.—Australia.

New South Wales: * Manildra, Oct., 1916 (det. Lloyd, No. 218, as above).

South Australia: * Kinchina, Aug., 1925.

The species was erected by Lloyd upon specimens in the Kew Herbarium collected by Drummond at Swan River and labelled by Berkeley *G. hygrometricus*. From Lloyd's illustration one would imagine the species to be a small-spored form of *G. floriformis*, but the specimens examined by the writer, determined as this species by Lloyd, are quite different. The plant is perhaps best separated by its subhygroscopic habit, and by the manner in which the basal portion of the endoperidium becomes arched and carries upwards the endoperidium, which appears as if seated on a broad, short pedicel. The thick rays of the exoperidium and the small spores, with their fine and even markings, are also characteristic. Were it not for the hygroscopic habit one would refer it to *G. rufescens*, for the mouth characters somewhat resemble those of this species as now defined. In fact the plant would appear to be intermediate between *G. rufescens* and *G. floriformis*.

Excluded Species.

a. *Geaster affinis* Col., *Trans. N.Z. Inst.*, xvi, 1883, p. 362.—This is probably a synonym of *G. triplex* or *G. velutinus*, but on account of the poor description impossible to place. No specimens are known.

b. *Geaster argentatus* Cooke and Massee.—The writer has been unable to locate the description of this species. Coker (1924) states there are specimens so labelled in the Herbarium of the New York Botanic Garden.

c. *Geaster coronatus* Col., *Trans. N.Z. Inst.*, xvi, 1883, p. 362.—The species is probably a synonym of *G. triplex*, but no specimens are known, so the point cannot be settled. In any case the name is preoccupied.

d. *Geaster argenteus* Cooke, *Grev.*, xvii, 1889, p. 75.—This species has been recorded from Australia, but it is probable this is an error, for specimens so labelled at Kew are, according to Coker (1924, p. 194), apparently specimens of *G. Drummondii*.

e. *Geaster hygrometricus* (Pers.) Fr., *Syst. Myc.*, iii, 1829, p. 19.—According to Lloyd (1905) there are no authentic specimens of this species from Australia in the herbaria of Europe. Probably the record was based on the plants at Kew upon which Lloyd erected *G. simulans*, for these were labelled *G. hygrometricus*.

f. *Geaster lugubris* Kalchbr., *Ungar. Akad. d.d. Wiss.*, xii, 1884, p. 10.—This is a synonym of *G. mammosus* Fr., a species which is not known to occur in this biological region.

g. *Geaster pusillus* Fr., *Pl. Preiss.*, ii, 1847, p. 139.—Lloyd (1905, p. 23) states: "No type exists and no one knows anything about it".

h. *Cyclocladema platyspora* Cke. et Mass., *Grev.*, xvi, 1883, p. 74.—This was based on an unopened *Geaster*, probably *G. velutinus*.

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EXPLANATION OF PLATES II-VII.

Plate ii.

- Fig. 1. Sulcate peristome of *Geaster campester*. $\times 2$.
 Fig. 2. Sulcate peristome of *Geaster Smithii*. $\times 2$.
 Fig. 3. Fibrillose peristome of *Geaster triplex*. $\times 2$.
 Fig. 4. Fibrillose peristome of *G. triplex* (form *lageniformis*). $\times 2$.
 Fig. 5. Fibrillose peristome of *G. umbatus*. $\times 2$. New Zealand form with farinose endoperidium.
 Fig. 6. Indefinite mouth of *G. floriformis*. $\times 2$.

Plate iii.

- Fig. 7. *G. pectinatus*. Natural size.
 Fig. 8. *G. pectinatus*. Natural size. Small form known as *G. Schmideli*. The two plants on the left could be labelled *G. Bryantii*.
 Fig. 9. *G. pilcatus*. Natural size.
 Fig. 10. *G. Bryantii*. Natural size. Note the farinose covering over the exterior of the endoperidium.
 Fig. 11. *G. ellipticus*. Natural size. Typical peristome is shown on the plant third from the left, on the right is a plant with two peristomes.
 Fig. 13. *G. campester*. Natural size. Note the different types of peristomes.
 Fig. 14. *G. campester*. $\times 3/2$. Showing the asperate endoperidium.

Plate iv.

- Fig. 12. *G. Hariotii*. Natural size.
 Fig. 15. *G. Clelandii*. $\times 3/2$. Plant on the right shows umbilicate base; note the asperate endoperidium.

- Fig. 16. *G. Smithii*. Natural size. Note the glabrous and polished endoperidium, and the sub-hygroscopic exoperidium.
- Fig. 17. *G. Drummondii*. Natural size. Expanded plant on the left. Note the glabrous nature of the endoperidium.
- Fig. 18. *G. Drummondii*. Natural size. Note the regular nature of the striae of the peristome.
- Fig. 19. *G. limbatus*. Natural size. Common form most frequently collected in Australia.
- Fig. 20. *Geaster limbatus*. Natural size. A form not uncommon in New Zealand. This has been determined by Lloyd as *G. rufescens*.
- Fig. 21. *G. limbatus*. Natural size. A form found in New Zealand, in which the endoperidium is covered with glistening particles.
- Fig. 22. *G. limbatus*. Natural size. The Australian form determined by Lloyd as *G. Readeri*.
- Fig. 23. *G. minus*. Natural size. The form as it commonly grows.

Plate v.

- Fig. 24. *Geaster arenarius*. Natural size. Note the hygroscopic exoperidium, the only character separating it from *G. minus*.
- Fig. 25. *G. arenarius*. $\times 2$. Peristome enlarged to show its fibrillose-fimbriate nature.
- Fig. 26. *G. velutinus*. Natural size. Note the different appearance the plant takes as it becomes weathered. Typical form in the centre.
- Fig. 27. *G. velutinus*. Natural size. Exterior of the exoperidium showing its tomentose nature, and on the plant on the left the prominent umbilical scar.
- Fig. 28. *G. mirabilis*. $\times 2$. Plants from Dr. Coker, U.S.A., growing on a mycelial subiculum on rotting wood. Immature plant on the left.
- Fig. 29. *G. triplex*. $\times 1/2$. Expanded plant; note the characteristic peristome and acuminate apices of the rays.
- Fig. 30. *G. triplex*. $\times 1/2$. Exterior of the exoperidium, showing its glabrous nature, longitudinal striae, and the umbilical scar.
- Fig. 31. *G. triplex*. Natural size. Unexpanded plant showing the glabrous exterior and the acuminate apex.

Plate vi.

- Fig. 32. *Geaster triplex*. $\times 2$. The form known as *G. Archeri*, showing the pseudo-sulcate peristome.
- Fig. 33. *G. australis*. Natural size. Immature plant on the left. Note the light colour of the glabrous endoperidium.
- Fig. 34. *G. fenestriatus*. Natural size. Note the fornicate nature of the plants on the right; on the left the plant has not assumed this condition.
- Fig. 35. *G. fenestriatus*. $\times 2/3$. This photo shows the cup at the base formed of the mycelial layer and the arched fibrillose layer from which the fleshy layer has partially flaked away, portion forming a collar around the base of the endoperidium.
- Fig. 36. *G. fimbriatus*. $\times 2$. The indefinite character of the mouth is well shown.
- Fig. 37. *G. floriformis*. Natural size. Hygroscopic plants; the one on the right is partially expanded.

Plate vii.

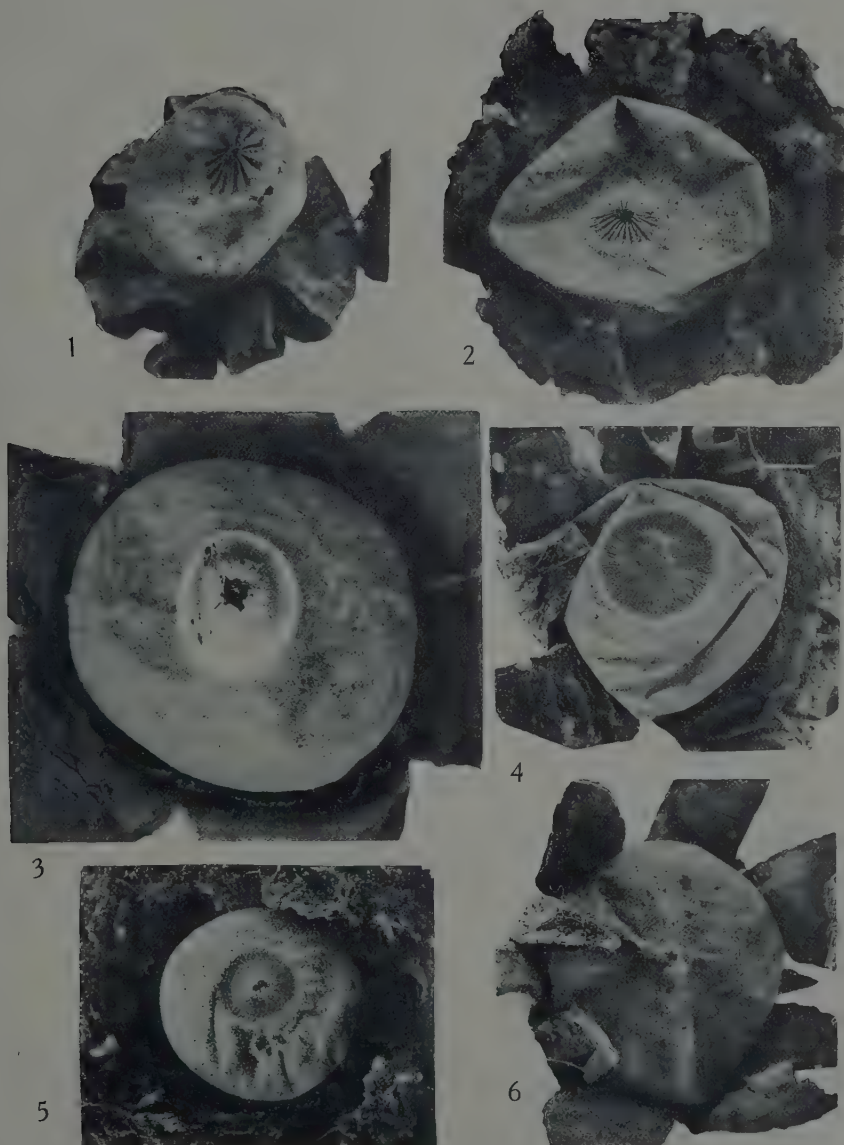
- Fig. 38. *G. floriformis*. Natural size. The plant on the left shows the umbilicate base, the one on the right the indefinite mouth.
- Fig. 39. *G. simulans*. Natural size. Central plant shows the umbilicate base; the one on the right the indefinite mouth.
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- Fig. 45. Spores of *G. triplex*.
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- Fig. 48. Spores of *G. simulans*.

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7, 8. *Geaster pectinatus*. 9. *G. plicatus*. 10. *G. Bryantii*.
11. *G. ellipticus*. 13, 14. *G. campester*.



12. *Geaster Hariotii*.

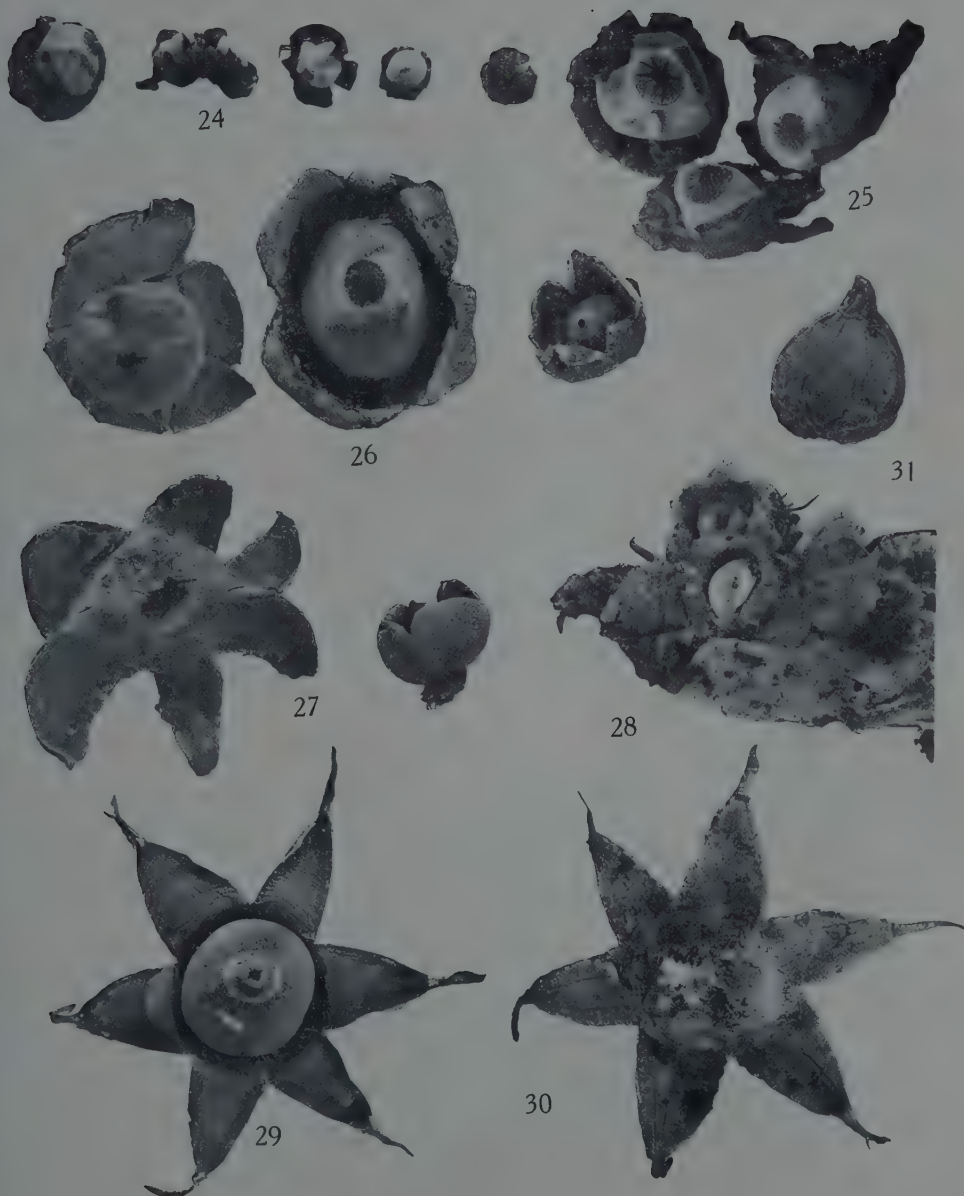
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17, 18. *G. Drummondii*.

19-22. *G. Umbatus*.

23. *G. minus*.



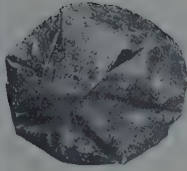
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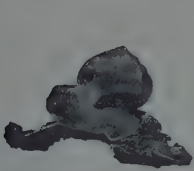
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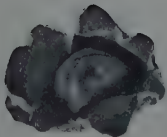
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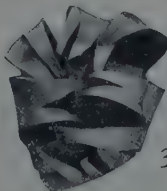
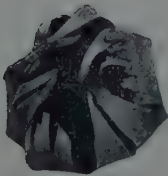
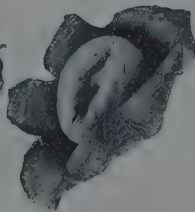
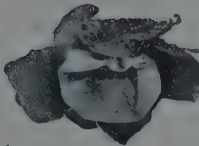
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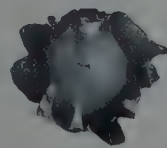
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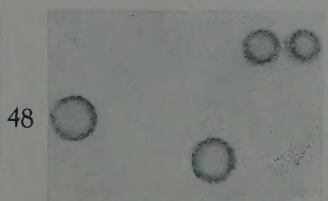
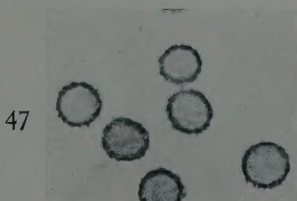
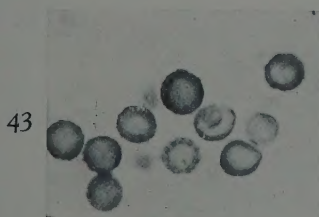
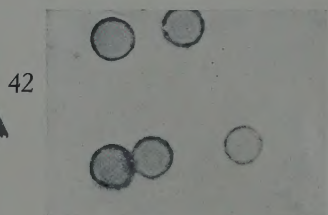
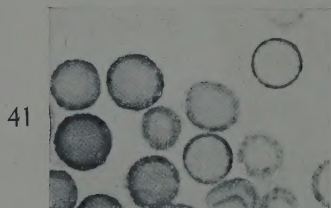
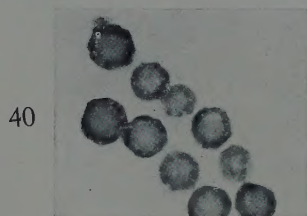
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36. *G. fimbriatus*. 37. *G. floriformis*.



38. *Geaster floriformis*. 39. *G. simulans*. 40-48. Spores of species of *Geaster*.

